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March, 1910

PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF AGRICULTURE

POULTRY DEPARTMENT

INCUBATION AND BROODING

— BY —

M. A. JULL



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PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF AGRICULTURE

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Secretary—A. E. Craddock.

Letter of Transmittal

Department of Agriculture,
Victoria, B. C., March 1st, 1910.

The Honourable W. J. Bowser, K.C.,
Minister of Agriculture:

Sir,—I have the honour to submit herewith a Bulletin dealing with Incubation and Brooding, compiled by the Provincial Poultry Expert, M. A. Jull, B.S.A. This information has been collected in order to meet the requirements of the Poultrymen of British Columbia. The information contained therein represents the latest scientific and practical methods as applied to Incubation and Brooding, and it is anticipated will be of valuable assistance to the Poultrymen of the Province.

I have the honour to be, Sir,

Your obedient servant,

(Signed) WM. E. SCOTT,
Deputy Minister of Agriculture.

The Bulletins of the Department are sent free to all members of Farmers' Institutes.

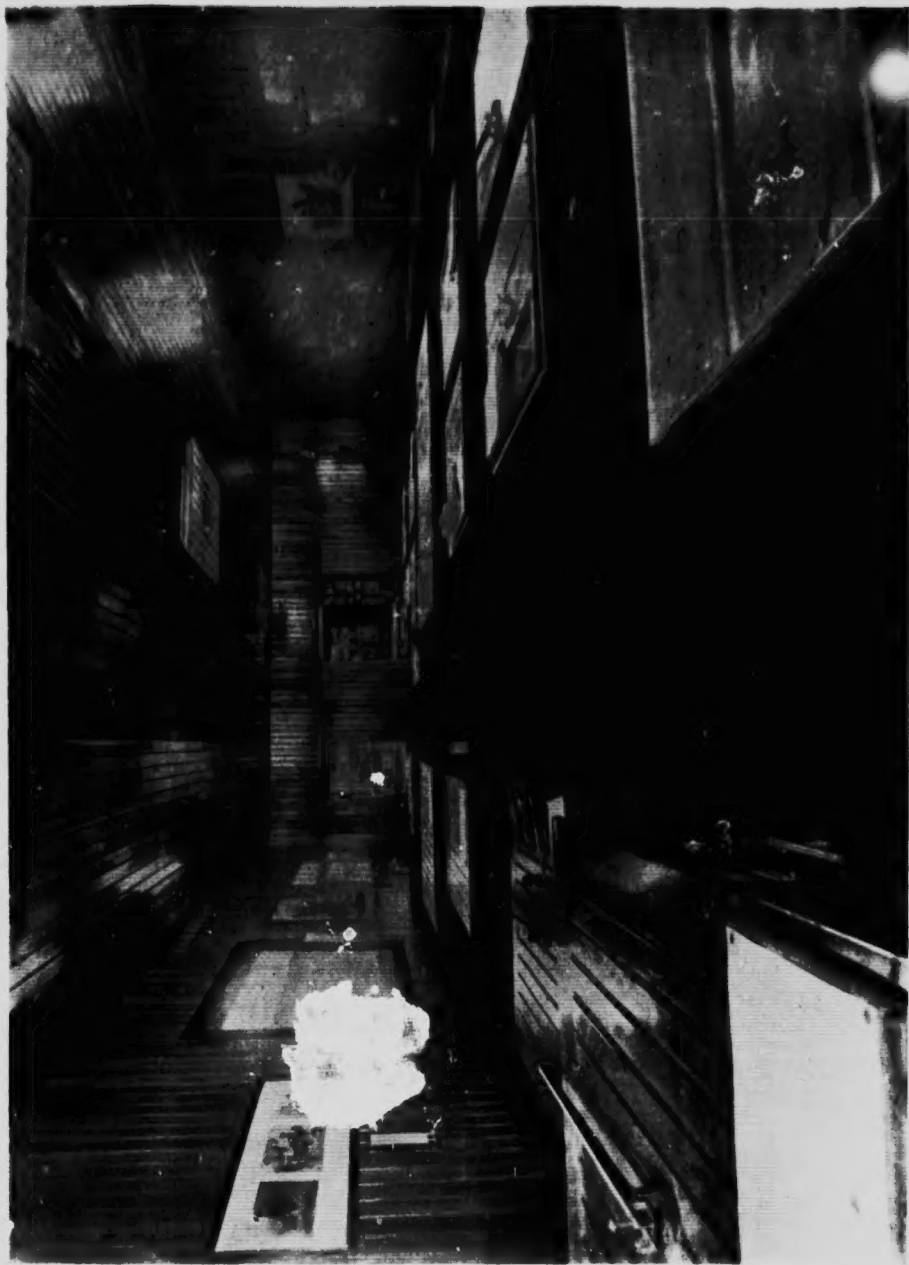


FIG. 1.—A British Columbia Incubator House.



PREFACE

The need for a publication dealing with the problems of Incubation and Brooding has been felt by those engaged in the raising of poultry, and for some time has expressed itself in the mind of the author. The demand for information in the various branches of the poultry industry is rapidly increasing. There are two influences which give rise to this demand. Those already engaged in the industry to a very large extent have had to solve their own problems; their experiments, performed often in a haphazard manner, proving of little value. They have had to conduct their poultry plants somewhat as an experimental station rather than as a business enterprise. For them to experiment is too costly. Then the need for such a bulletin as this, which it is hoped will aid the poultrymen to solve many of the perplexing problems confronting them, is obvious. On the other hand, many new-comers to the Province are desirous of obtaining literature dealing with the best methods to adopt in order to be assured of the best success. The business of the Department is to assist these as far as possible, and with this object in view, this bulletin has been prepared.

Knowledge, to be of the greatest value, must be disseminated. It is impossible, however, for one in a single bulletin, or even in a number of bulletins, to reach the exact needs of every reader. In the first place, because of the varying local conditions throughout the Province, any attempt to give specific instructions would detract from the value of the bulletin as a whole. Secondly, it is not wise to endeavor to publish such detailed information. Rather, through emphasis of the general underlying principles of incubation and brooding, this bulletin is intended to stimulate independence of thought on the part of every individual.

This work differs somewhat from others that have been sent out from other Departments of Agriculture, Colleges and Experiment Stations. The majority of bulletins published by the Poultry Departments of Agricultural Colleges and Experiment Stations deal largely with results of investigations carried on in these Institutions. Such works are naturally of invaluable service to the

poultry industry of the country in which the experimental work was carried on. These results will not be referred to in this bulletin, partly because they may be of no practical value to the industry of the Province, and partly because the experiments were not conducted under conditions which we experience. Many questions have from time to time suggested themselves as worthy of investigation, and it is hoped that in the near future information dealing with practical results from experimental work in this Department will be available for the public. A chapter has been included on the embryological development of the chick. The influence of the factors involved in the hatching of chicks may be more clearly understood by a careful perusal of this chapter. The following chapter deals with the very important question of obtaining fertile eggs that will produce chicks of strong vitality. Too often this question has been overlooked by writers on the problems of incubation. Considerable information dealing with Pacific Coast methods is included.

The acknowledgments of the author are due to Mrs. G. D. Church and Mr. Wm. Harriss, of the Petaluma Egg Exchange, Petaluma, California, and Mr. Frank H. Snow, Editor of the Petaluma Poultry Journal, for kindly assistance in research work. I am also indebted to Prof. James Dryden, in charge of the Poultry Husbandry Department of the Oregon Agricultural College, Corvallis, Oregon, for figures 8 and 17; Mr. H. L. Blanchard, in charge of the Poultry Husbandry Department of the Washington Agricultural Experiment Station, Puyallup, Washington, for figure 16; Professor Jas. E. Rice, in charge of the Poultry Husbandry Department of the Cornell College of Agriculture, Ithaca, N. Y., for figure 7, and Professor W. R. Graham, of the Poultry Department of the Ontario Agricultural College, Guelph, for figure 14.

M. A. JULL.

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INCUBATION AND BROODING

INCUBATION

From the lowest to the highest forms of animal life we find a gradual deviation in the method followed for the perpetuation of each form of life from generation to generation. The hatching of chicks from eggs, which have been produced by the mother hen, is a very similar process of reproduction in other animals. The renewal of the flock depends upon incubation, natural incubation in turn, being dependent upon the instinct of the mother hen. It seems to be conducted by the modern hen in much the same manner as do the wild birds, or as the wild fowl of the jungles of India used to do.

In countries where artificial incubation has been practised for centuries, the hen has abandoned that part of her work. It was practised before the dawn of the Christian Era; and in Egypt, where the eggs are incubated in immense ovens, no hens are employed. In America the incubator has been the chief factor in the advancement of the industry. It is quite possible that as artificial means are more universally adopted, and the natural method resorted to less frequently, that strains with larger egg records may be built up. However, it is not inferred that the incubator is superior to the hen for hatching chicks. The point to be noted is that the incubator can hatch the chicks while the hen continues in the production of more eggs.

The theory of incubation is based upon the fact that, if a fertile egg is kept under proper conditions for a sufficient period of time, it will be transformed into a living organism. The incubation period varies with the different species of fowl. For the egg of the common hen, the average period is twenty-one days. If proper conditions exist and everything has been favourable throughout the period, the chicks will probably emerge on the twentieth day. Chicks have been known to hatch on the nineteenth day. On the other hand, if the weather be extreme, and if unfavorable conditions exist, such as a negligent sitter, if the hen is being used—or with the incubator if it has not been properly looked after, the chicks are not likely to pip until the end of the twenty-first or even on the twenty-second day. Then again, eggs have been incubated twenty-three days. The same applies to eggs from other fowls, except, of course, that each class has its own period of incubation. The period

for the following classes of fowl are: Hen, twenty-one days; Guinea, twenty-five; Duck, twenty-eight; Turkey, twenty-eight; and Goose, thirty.

THE DEVELOPMENT OF THE CHICK

For a clear and comprehensive understanding of the phenomenon of incubation, it is essential to have a general knowledge of the embryological development of the chick. The structure of the egg is first taken up, followed by a treatise on the process of development of the chick within the egg.

Structure of the Egg

The most external structure of the egg is the shell, which is of organic material, impregnated with calcareous salts. This more or less hard shell presents a somewhat roughened surface and is very porous. The shell is the last structure to be formed, and as the egg

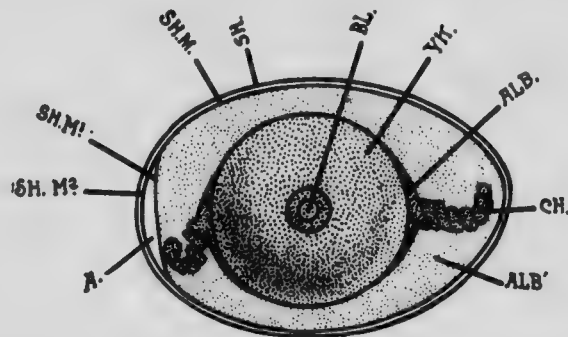


FIG. 2.—A HEN'S EGG AT TIME OF LAYING.

a., air space; *alb.*, dense layer of albumen; *alb'*, more fluid albumen; *bl.*, blastoderm; *ch.*, chalazae; *sh.*, shell; *sh. m.*, shell membrane; *sh. m'*, *sh. m²*, its two layers separated to enclose air space.

passes through the oviduct, calcareous salts are deposited, the roughness being due to the presence of villi of the formative membrane. Through the pores the interchange of gases between the interior and exterior air takes place, allowing for the process of respiration during incubation. The embryo in its development requires oxygen, which is admitted through the porous shell, and by this means also carbon dioxide is thrown off. The air contained in the air space (Fig. 2) gains access in the same manner. Lying close to the shell is the shell membrane—which is of two layers, sometimes called the inner and other shell membranes. These are closely attached to one another, except at the large end of the egg,

where they are separated somewhat to form the air space (*a*), as in Fig. 2. Air may also permeate these membranes. Filling the space inside the shell membrane is the white or albumen (*alb.* and *alb'*) of the egg, in the centre of which, in turn, lies the yolk (*yk.*). At opposite poles of the yolk, and apparently attached to it, are the chalazae (*ch.*), composed of coiled membranous layers of dense albumen. The chalazae were formed in this way while the albumen was being secreted in the oviduct. Their function is to moderate the effects of any unsteady movement of the egg, and to keep the yolk more steady in the albumen. The yolk is bright yellow in colour, spherical in shape, and about an inch in diameter. It is surrounded and held in shape by a thin vitelline membrane, and exhibits on one side, normally the upper one, no matter how the egg has been opened, a small whitish circle, the cicatricula or blastoderm (*bl.*). The blastoderm of the fertile egg will show an outer white rim, as seen in Figure 3, and within that a circular transparent area, in the centre of which again, there is an opaque area. Whatever may be the position of the egg, the blastoderm is always found to be uppermost. This occurrence is accounted for in its lesser specific gravity, and of that portion of the yolk immediately surrounding it. Such a condition in which it is so carefully protected would lead us to believe that it must have an important function to perform. The necessity of such a careful provision for its safety is made clear when we realize that within it life in the embryo is first manifested. When a hen sits upon a fertile egg for twelve hours or more, certain changes take place, the first noticeable of these being within the blastoderm. In order that it may receive the heat from the body of the hen, the necessity of its always being uppermost, is apparent.

The Growth of the Chick

The preceding is a description of the egg at the time of its laying. Such an egg has already passed through its earlier stages of development, and is in a resting condition, simply awaiting suitable conditions of temperature, moisture, etc., for its further development. Although of so large a size, the yolk of a hen's egg is a single cell, its great size being chiefly due to the large number of yolk granules which it contains. These yolk granules serve as food for the developing embryo, the development of which is first seen to take place within the blastoderm (Fig. 3). Since the processes of the development of the ovum before the egg is laid are so complicated, and also because a discussion of them is of little practical value, they will not be taken up here. Many processes of the development of the embryo during the twenty-one days of incubation are also omitted, chiefly because a discussion of them would be of little interest or value, and also a lengthy treatment of these minor factors is not justified. It is more important that the reader

may have a clear understanding of the general principles involved in the development of the chick.

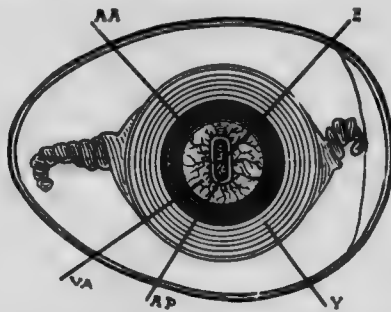


FIG. 3.—A HEN'S EGG AFTER ABOUT FORTY-EGHT HOURS INCUBATION.

aa., area opaca, or that portion of the blastoderm which extends over the yolk as the germinal membrane; *va.*, vascular area; *ap.*, area pellucida, in the centre of which lies the embryo, *e*; *y.*, yolk.

During incubation, the blastoderm continually increases in size, until it completely encloses the yolk. While this is taking place, the embryo, resting above the yolk, grows rapidly, and sends out blood vessels through its area. These blood vessels supply nourishment to the embryo, which they obtain from the yolk. As the embryo continues in growth, changes in its structure rapidly take place. The most important change that takes place during the first twenty-four hours of incubation is the beginning of the head. From the twenty-fourth to the thirty-sixth hour, the embryo not only becomes much more clearly outlined, but its texture becomes more firm. During this period, the formation of the tubular heart and of some of the blood vessels takes place. From the thirty-sixth to the forty-eighth hour, the formation of the eyes and ears and the rudimentary chambers of the heart is undergone. The circulation of the blood system is definitely established.

It is during the third day that the most prominent changes occur. Up to the present no lungs have been formed, and on the third day a system of breathing is established by means of gills. The chambers of the heart are further developed, and the formation of the nose is begun. The heart, nose, eye and other formations may be distinctly seen in Figure 4. The nervous system is definitely established and the fore-gut and hind-gut are formed; the former being separated into oesophagus, stomach and duodenum, and the latter into large intestine and cloaca. The liver and pancreas appear just posterior to the stomach. On this day also the lungs make their appearance as diverticula from the oesophagus, just anterior to where it enlarges to form the stomach. The position of the

lungs should be carefully noted. They are developed immediately beneath the vertebral column, and are not provided anatomically with very great protection. Then it is easily understood how the adult chick may become chilled quickly or become overheated as quickly.



FIG. 4.—SURFACE VIEW OF AN EMBRYO OF 52 HOURS.
a., vitelline artery; *e.*, eye; *h.*, heart; *n.*, nose; *t.*, tail.

At the end of the fourth day of incubation, the embryo has greatly increased in size, and on account of the rapid absorption of the white of the egg, it lies very close to the shell. The limbs make their first appearance, as local thickenings just back of the heart, and just in front of the tail. The heart is divided into right and left sides. There are no very striking features to be noticed during the fifth day, the changes that take place being the growth and development of the structures that have originated during the previous days. In the increased growth of the limbs, the cartilages, elbow and knee joints appear. Different parts of the face are developed.

Up to this time, there is nothing about the embryo that would enable the inexperienced eye to distinguish the chick embryo from that of many other and quite different animals. In fact, the embryo of the chick at this stage of development is very similar to the embryo of the pig, deer or other animals at the same stage.

On the eighth, ninth and tenth days, the yolk is beginning to diminish rapidly. Little sacs containing the feathers begin to protrude from the surface, especially along the back of the rapidly



FIG. 5.—Chick embryo at about the ninth day of incubation.



FIG. 6.—After twenty-one days of incubation.

growing embryo. On the tip of the nose is a chalky patch, the beginning of the horny beak. By the eleventh day the abdominal walls, though much less firm than those of the chest, may be said to be fully formed, and the loops of the intestines which have been hanging down are enclosed in the body cavity. The body is thus almost completed. By the thirteenth day the feathers are generally

distributed over the body. They remain enclosed in the sacs until the nineteenth day, when they are an inch or more in length. On the thirteenth day, nails and scales appear on the toes, and by the sixteenth day the nails, scales and beak are all quite firm and horny. By the sixteenth day the white has disappeared, and on the nineteenth day the remains of the yolk are withdrawn bodily into the body cavity, which was not nearly filled by the loops of the intestine. If the eggs are incubated in such a manner that the yolk-sac is not completely absorbed, bowel trouble is certain to result. About the twentieth day, the beak is thrust into the air space, and the chick, for the first time, begins to breathe by means of its lungs. The changes in actual structure that take place at the time of hatching are comparatively slight, but they produce remarkable changes in the course of the circulation, and convert the embryonic circulation into that of the adult chick. In a few hours from the time of first breathing the outer air, the chick, with rapid blows of its horny beak, soon breaks the shell around the broad end of the egg, and quits its primitive home.

THE PRODUCTION OF EGGS SUITABLE FOR HATCHING VIGOROUS CHICKS

This important problem has been too often neglected, and many reliable incubators have been condemned when the trouble really has been with the eggs used. The best of success, either in natural or artificial incubation, can only be expected with eggs which will hatch well and produce strong, vigorous chicks. The successful renewal and improvement of the flock is not wholly a problem of incubation. It is only one of many factors, and one which, for the time being, we must consider as a means to an end. If breeders would use more care in the selection of their breeding stock, and adopt improved methods of breeding, more satisfactory results would follow in the hatching of chicks.

If the germs are naturally weak, the most careful attention during the incubation of the eggs and the brooding of the chicks will not make up for their lack of vigor. Negligence with the breeding stock, or improper systems of breeding, is often the cause of poor hatches and weak chicks.

The vitality of future generations depends upon practices followed at present. The breeding stock is the foundation upon which business is built up. The flock should have abundance of constitutional vigor, be well housed, receive proper food, and should be carefully managed at all times.

Importance of Constitutional Vigor and Vitality

The first and probably the most important problem in the poultry industry is to maintain and increase the constitutional vigor



FIG. 7.—Four chickens of the same variety, age and method of rearing. The difference in size is apparently due to an inherited weakness.

(Courtesy New York State College of Agriculture.)

of the flock. In this age of breeding for heavier layers, this vital question is apt to be overlooked. Many breeders have increased the productivity of the hen, but at the same time have weakened her constitution. The value of a strong constitution was not realized until the health of the hen was seriously affected. Naturally, if a hen is expected to produce more eggs in a year, she must develop a stronger constitution to withstand the increased demands made upon her. On the other hand, a poor layer does not generally exhibit the best type of health and strength. What is most needed is, firstly, to breed for health and vigor, then, secondly, more eggs or flesh.

The Male

Care should be exercised in the selection of the male, since his influence in the flock is so great. He should be fully matured and well developed, though not too heavy, as heavy breeders often seriously injure the females. That he be a sound bird constitutionally is of vital import. His head should give every evidence of masculinity, combined with quality. It should be of good size and of good shape, and should also be well carried. A bright eye and

a rather short, stout beak are other requisites. The body should present a symmetrical appearance, being filled out and carried well. In general, he should be active, a bird of quality and one possessed of abundance of vitality and vigor.

The Female

The above general characteristics may be applied to the female. A two-year-old or a yearling, or a well-grown, well developed and fully-matured pullet may be used. Many times the vigor of the flock has been greatly reduced by breeding from immature pullets. In some places, where the raising of poultry is the main industry, the size of the fowls has been reduced in just this way. Breeders are beginning to realize the necessity of breeding from fully-matured, well developed fowls, if vitality, vigor and prolificity are to be maintained year after year. Indications as noted in the male will suffice to differentiate the desirable from the undesirable type. Generally speaking, about ten or fifteen females is considered a sufficient number for one male.

Housing of Breeding Stock

The necessity of fresh air is being realized to a greater extent than ever before. Poultrymen are finding that to have the best success with their breeders, they must be kept under as natural conditions as possible. Fresh air is of great value, especially at night. Besides keeping the birds in fresh-air houses, they must be given free range. Free range for any class of fowls will give better results than when they are under confinement or restricted in any way. An economical and convenient colony house is illustrated and described in a subsequent chapter, thus a discussion of house construction is omitted here.

The Feeding of the Breeding Stock

A variety of wholesome food, grain, plenty of green stuff, pure water, animal and mineral food, are essentials. The hatchability of chicks is affected by the foods used, as well as by the method of feeding. Dry mash, kept before the fowls at all times, is preferable to wet mash. It is best to feed the dry mash in hoppers, as in this way it is kept before them all the time in a clean state. Wheat, bran, cornmeal, crushed oats, middlings, beef scraps and gluten meal are most commonly used in making dry mashes. The proportion of these materials may be varied with equally good results. It is well to balance up the ration as evenly as possible, so that the breeders may be kept in the best of health. Too much light, bulky food, or too large quantities of the very concentrated materials

should be avoided. Some good mashes which are largely used are the following:—

Mash No. 1—By measure, 4 parts bran, 2 middlings, 2 ground oats, 1 cornmeal, 1 ground barley, $\frac{1}{2}$ linseed meal and $\frac{1}{2}$ beef scraps. This is a very well balanced ration, though some changes could be made. The quantity of middlings may be reduced, or the quantity of beef scraps may be slightly increased. If green cut bone is available, beef scraps may be taken out of the mash altogether.

Mash No. 2—By measure, 4 parts bran, 4 ground oats, 2 cornmeal, 1 middlings, 1 cut alfalfa (well cured) and 1 part beef scraps. This mash provides for green food and care should be taken to have this well cured, otherwise there will be a great deal of fibre, which is more or less indigestible. Field beets and cabbages are other forms in which green food may be supplied the breeding stock.

Of the staple grains, wheat and oats are more easily obtained. It is advisable to use as much variety as possible. However, the grains should not be fed exclusive of other materials. Many poultrymen do not supply their breeding stock with enough green food. Whenever possible, the birds should be allowed unrestricted range, as this gives them to a certain extent a chance to balance their rations by means of insects and other delicacies, besides the green food which they secure. They are also induced to take plenty of exercise, which tends to keep their blood in circulation. Skim milk may be given as a drink, along with water. Oyster or clam shells, as well as grit, should be constantly kept before them. These may be kept in self-feeding hoppers.

EGGS USED FOR INCUBATION

Together with the selection of the breeders, a careful selection should be made of the eggs laid by the breeding stock. A poor egg, even from one of the best breeders, should not be used. A poorly-shelled, an unevenly-shaped egg, or one otherwise lacking in qualities which make up a good egg, should be discarded. The normal egg is one of average size, weighing about one and five-sixths or two ounces, with a smooth surface and an even shape, being slightly larger at one end than the other. An examination only of the external appearance of the egg is not sufficient. An egg may appear to be all right, but when tested or candled, it may be found to be absolutely worthless. There is nearly always a percentage of eggs from any flock which have never been fertilized. There may be also broken yolks, "buttermilk" eggs, "green" eggs, "blood yolks," and broken shells. None of these, of course, are satisfactory for incubation. A "buttermilk" egg is one which, when candled, presents a coarsely spotted appearance, and does not seem to contain in proper proportion all necessary constituents. A

"green" egg can only be detected by testing. Generally at its small end it presents a greenish appearance. It is claimed that such an egg is produced by fowls which consume excessive quantities of green food where whole grains and mashes are lacking. "Blood" yolks are distinctly red in color, and are not desirable. These eggs are even rejected by cold storage firms when they candle their eggs before storing. Poultrymen would save a great deal if they would test their eggs before putting them in the incubator and take out all eggs which could not, under the best conditions, produce chicks. Every egg which does not produce a chick is a loss. If abnormal or faulty eggs are used, chicks hatched from them may lay faulty eggs. To breed strains that will lay the best of eggs, it is important to select and incubate only the best.

PRACTICAL PROBLEMS IN INCUBATION

NATURAL INCUBATION

On many farms, the number of fowls kept is too small to warrant the use of an incubator. On such places the chicks are hatched by the hen, and for such as use this method these remarks are intended.

The process of hatching and raising chicks by natural means seems to be somewhat simple and easy. The ability of the mother hen, if given a proper chance, to successfully hatch and rear a healthy brood of chicks is apparent when we realize that whenever possible she steals away and in due time returns with her brood, which she raises with little or no loss. On the other hand, in many cases where the hen has attended faithfully to business, only a few chicks have hatched and a large percentage of these have often died. Such results must, of course, have been due to defective eggs.

The first essential to successfully raise chicks with hens is fertile eggs from healthy and vigorous breeding stock. Another essential is to use medium sized hens, with properly constructed nests. Having these, it is also quite necessary that careful attention be given during the incubation period.

The nests should be carefully built of fine, soft straw or hay, and of such a size and shape that the hen will fill it nicely, affording complete protection for the eggs. Although the nest should be reasonably flat on the bottom, care should be taken to avoid the eggs coming into contact with the floor. The nest should be placed in such a position that the hen will not have to fly or jump into it. If placed on the floor, there will be little danger of broken eggs.



FIG. 8.—Coop constructed of four compartments in which four hens may be set. This coop may also be used for brooding the chicks and may be later converted into a small colony house.

(Courtesy Oregon State Agricultural College.)

The sitting hen should be given a variety of food, principally consisting of hard grains. A hopper of dry mash may also be within access, also some form of green food should be supplied. Pure water and grit should never be wanting.

Every means should be taken to insure the absence of mites and other vermin. A dust bath should be provided, and the hen should be thoroughly dusted with some good commercial insect powder when placed on the nest, and once or twice before the brood comes off. When the chicks come off they should be treated for head lice and should any be found treatment should be given at once.

ARTIFICIAL INCUBATION

The rapid development of the poultry industry within recent years has been largely influenced by the improvement of the incubator. Of course, the chief factor in the advancement of the industry has been its relative value to mankind. Increased demands

have been made for all kinds of staple food products, and of these, poultry produce, especially eggs, is demanded most. Along with the constant and increasing demand, prices have been gradually rising. Moreover, the hen manufacturer's the finished products, eggs and poultry flesh, with less expense to the country than is involved in the production of many other staple foods. In other words, of all agricultural industries, that of poultry-raising is one of the most economical.

The Incubator

Then it is seen what an important position the incubator holds. At the same time one must realize that there is a great difference between different makes of incubators. The use of the standard makes will prove more satisfactory. Many machines have been placed on the market which will hatch successfully for one or two seasons, and then practically become worthless. They have been constructed of cheap materials, have not been put together very well, and cannot be relied on to give satisfactory hatches season after season. These machines should be avoided, for as soon as they become unreliable they are valueless, and eggs placed in them are usually a total loss. Therefore, it is wise to take no risk with inferior makes, but secure durable and efficient machines with which to do this important work.

There are many different kinds of machines, but a description of all of them is quite impossible in a publication of this kind. They are nearly all constructed on similar principles, and along the same lines. The majority of them receive their heat from lamps that burn kerosene. In some places gas is being used for heating purposes. Recently a few makes have been constructed with electrical attachments. However, the employment of gas or electricity in incubators depends largely upon local conditions, and these methods of hatching chicks will not be discussed here.

The hot-air and hot-water incubators usually hatch with equal success, each involving the same general principles, with slight variations of minor importance.

The Location of the Incubator

Much depends upon the location of the incubator, for the reason that influences external to the incubator may influence the hatch. The incubator cellar should be well ventilated, thus providing for an abundant supply of oxygen for the developing chicks. Although fresh air is essential, direct draughts through the cellar should be avoided. Should draughts occur, it would be much more difficult to regulate the incubator properly. The cellar should be clean and light. It is quite advisable, however, to keep the incubator chamber dark while the chicks are hatching and until after they



FIG. 9.—A California Incubator House.

are removed. A dark egg chamber tends to keep the chicks quiet. If light enters at the front they will crowd one another in trying to reach the lighter portion of the chamber, and some may drop into the nursery tray before they are dry or "fluffed out," which is not desirable. The most successful incubator rooms are built half in the ground and half above ground. A house four feet in the ground and three or four feet above, makes an ideal place for the incubator.

The Operation of the Incubator

The degree of success in incubation depends to a great extent upon the operation of the incubator for the first week. It may be well to point out that it is very desirable, especially for amateurs, to follow the directions of the manufacturer more or less closely. The incubator should be started a few days before the eggs are to be placed in the egg chamber, so that a temperature of 103 degrees may be readily maintained. The temperature which the thermometer should register, however, depends somewhat upon its position in the incubating chamber. A temperature of 103 degrees

should be the registered temperature on a level with the tops of the eggs as they lay upon the trays. The eggs should not be placed in the incubator until a fairly uniform temperature has been maintained. When the machine is in good running order, the regulator should be adjusted properly to make accurate records of any variations in temperature. Another important factor which has to do with the maintaining of a uniform temperature is the flame. The wick of the incubator lamp should be trimmed in such a manner as to give a broad, even flame, the corners of which are slightly rounded. The wick should never be cut with scissors or any other instrument. When a new wick is to be used the rough edges should be burned off by holding the end of the wick in the flame of a lighted match. When the wick is in use it should be trimmed in the following manner. With the fingers rub off the charred portion carefully and light. If an even flame does not show as the wick is turned up, remedy the defect and then round off the corners of the wick so that no smoking will result.

The eggs require to be turned often. The purpose of turning them is to prevent the embryo in the egg from sticking to the shell, for should this occur growth would be stopped. For all practical purposes it seems that turning twice a day is sufficient.



FIG. 10.—Egg tester.

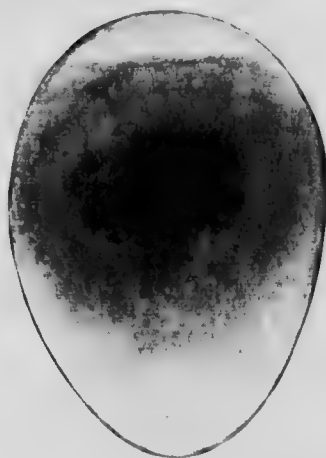


FIG. 11.—Showing unfertile egg.

Testing

The germ will show signs of development within a few hours of its first exposure to heat. It is not until about the fourth or fifth day that a very marked difference between fertile and unfertile eggs

may be detected with the naked eye. The unfertile eggs and those with dead germs are usually tested out twice during the hatch. Some poultrymen think it advisable to test three times, the first testing being done on the fourth day. There are certain advantages in this, though it is difficult for a novice to candle the eggs at that time. Any doubtful eggs could be removed and would thus be saved. The process of testing is simple, after a little experience is acquired. The tester most frequently used is shown in Figure 10. The appearance of the egg can be clearly seen when placed between the light of the tester and the eye.

Fig. 11 shows unfertile egg, while Fig. 12 shows a fertile egg on the seventh day of incubation.

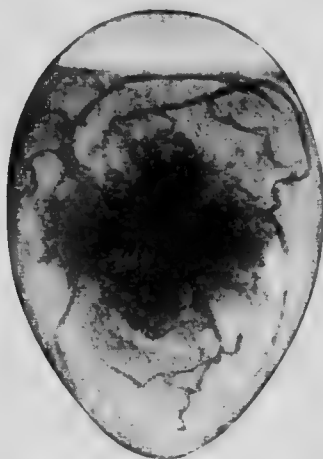


FIG. 12.—Fertile egg on seventh day of incubation.



FIG. 13.—Egg with broken yolk.

In Figure 13 is shown an egg with a broken yolk,¹ which, of course, could not hatch.

The testing is usually done on the seventh and fourteenth days.

The air cell should also be noted, while testing. As incubation progresses, the air cell will become larger, until at the last the fully-formed chick completely fills the shell, as shown in Figure 6. The size of the air cell indicates to a greater or less degree the amount of moisture the egg is losing, consequently its condition is more or less directly connected with ventilation and moisture.

There are other perplexing problems in incubation, of which may be mentioned ventilation, carbon dioxide and moisture. These problems have been in the minds of prominent investigators for a

number of years, and as yet few are agreed as to the best methods to adopt in respect to any one of them.

During the development of the embryo, oxygen is absorbed and carbon dioxide is thrown off. If an excess of this carbon dioxide accumulates in the egg chamber, it will be detrimental to the best development of the embryos. For good results the egg must be given fresh air. The circulation of the air through the incubating chamber should be rapid enough to supply sufficient oxygen for the living embryo. If, on the other hand, ventilation is too rapid, the eggs will lose much moisture, which, in turn, would tend to retard growth and probably destroy the hatch. If the evaporation of the watery content of the egg is excessive, moisture must be supplied. If moisture is supplied from the beginning, it tends to produce a quick-growing embryo. When hatched the chick will be large, but it may show lack of vigor. However, many successful incubator operators supply moisture from the beginning. It should be supplied especially during the latter part of the hatching period.

The eggs should be aired a few minutes every day. Under natural conditions the eggs are aired whenever the hen leaves the nest for feed. As the incubation period lengthens, they may be aired a little longer than in the beginning. While being aired, they should be covered with a woollen blanket. This will prevent too rapid evaporation of the watery content. Of course, the egg chamber of the incubator should be kept closed.

At hatching time, as above noted, the incubator chamber should be kept dark. The chicks should not be removed from the incubator until thirty to fifty hours after hatching. This will give them a chance to become thoroughly dry and will also allow of the final absorption of the contents of the yolk sac. During this time the temperature should be gradually lowered, as in this way the chicks are "hardened off" gradually, and will be better prepared for the brooder.

BROODING

The brooding of chicks does not present so many problems as incubation, though these problems have an important bearing upon the successful raising of poultry. The life of the chick is dependent largely upon the parent stock, as well as upon the method of incubation, and finally upon the method of brooding. The influences of the methods of brooding are probably not so great as those of incubation, and more especially of the influence of the breeding stock, because the chick is in a more advanced state of

development, and can withstand greater variations in methods adopted. On the other hand, a fine lot of vigorous chicks may be hatched from eggs from the best of stock and, through improper methods of brooding, totally unsatisfactory conditions may result.

The main thing in brooding is the temperature. Little chicks, three or four days old, are fairly hardy creatures, but when placed under extreme conditions, weakness or death is sure to follow. The chick's lungs are situated along the spinal column, and are protected only by a thin membranous lining over which a light covering of feathers grow. Provided with such meagre protection, the lungs may become readily chilled, or overheated. An even temperature, with as few variations as possible, is most desirable. The brooder should be started up a day or two before the chicks are ready to be placed in it, so that an even temperature of about 98 degrees may be maintained. This temperature should be gradually lowered, and it depends upon the season of the year just how much it should be lowered. The poultryman must use his judgment and operate the brooder according to the condition of the chicks. Many poultrymen, especially with large flocks, use no thermometer in their brooders. They study the chicks, and can tell by looking at them if the temperature is right. This emphasises the fact that for best success the poultryman must understand his business.

Another problem, second in importance to temperature, is that of foods and feeding. On the nineteenth day of the incubation period, as was noted in the chapter on The Development of the Chick, the remains of the yolk are withdrawn bodily into the body cavity. The food contained in this absorbed yolk provides for the chick's sustenance until it is able to obtain food by its own efforts. It is due to this provision that it is not wise to give it any food for about fifty hours.

BROODING CHICKS BY THE NATURAL PROCESS

At present the small grower of chickens in many cases depends upon the aid of the hen in the reproduction of the flock. Many find it necessary to use the hen entirely in the hatching and brooding of the chickens. To persons so situated, a brief outline of some of the best methods to adopt may be helpful. When the chicks have hatched and are prepared to leave the nest, they should be carefully examined for lice. The hen should be thoroughly dusted with fresh insect powder, and oil is effective when applied to the head and under the wings of young chicks. Care must be taken not to get too much on them, especially during damp weather. The hen with her brood should not be disturbed too frequently during the first few days after hatching. To keep warm is of more importance than feed. As the chicks develop they require less restricted quarters, but it is wise to keep the mother hen confined. If chicks

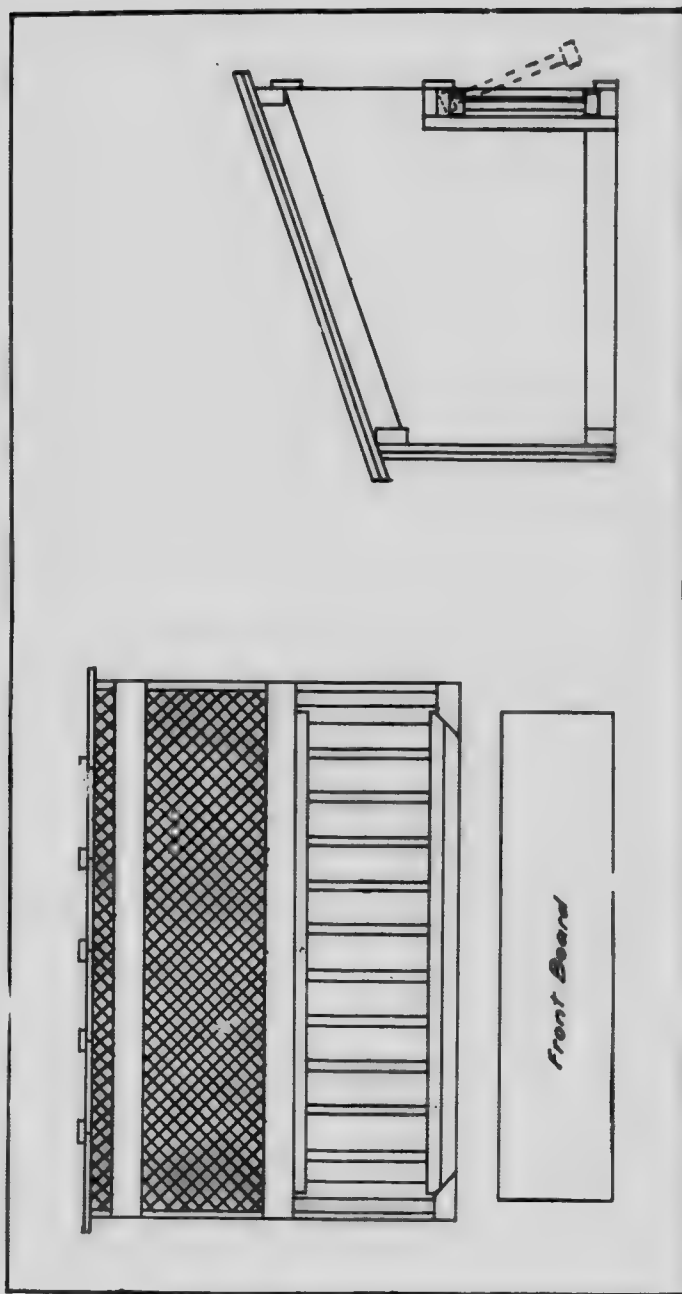


FIG. 14. Showing construction of a convenient coop for hen and chicks.

(Courtesy Ontario College of Agriculture.)

are allowed to run through long wet grass or grass heavy-laden with dew, it interferes with their growth. Dampness is one of the greatest drawbacks in the poultry industry.

A good coop in which to keep the mother hen is shown in Fig. 14. This coop is easily constructed and may be moved about readily. It is two feet high in front, fifteen inches high at the back, and is two wide by three in length. The wire portion is one foot in width. The board may be used to cover the front at night. The feeding of the chicks is practically the same as for chicks raised with the brooder.

BROODING CHICKS BY THE ARTIFICIAL PROCESS

There are many different methods employed in the brooding of chicks. The advantages and disadvantages of these methods will be pointed out.

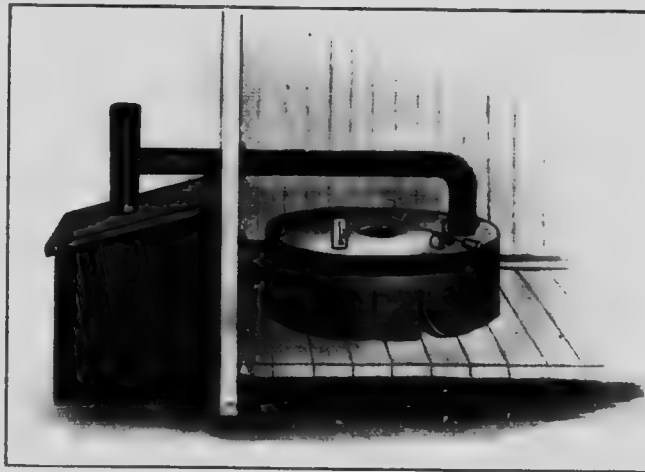


FIG. 15.—Round hover. About fifty chicks may be brooded under one of these hovers.

The Colony System

Nearly all small breeders, and a few of the larger ones, employ the colony system in brooding their chicks. The round hover, as shown in Fig. 15, is used probably more than any other. This hover may be placed in almost any kind of a house, and is sometimes used in long continuous houses. It gives very good satisfaction, and is easily operated. About fifty or sixty chicks may be brooded under one hover, until they are five or six weeks old.



FIG. 16—Small colony coops where chicks are raised with the round hover brooders. These coops have removable curtain fronts.
(Courtesy Western Washington Experiment Station.)

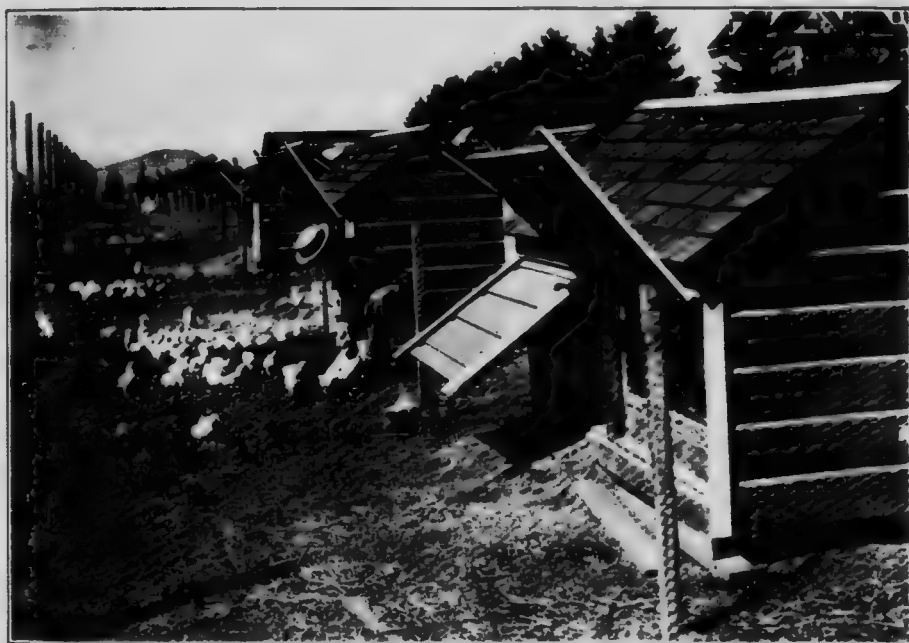


FIG. 17 Colony coops. Each coop is divided into two sections: one section having the hover while the other section is used as a scratching compartment.

(Courtesy Oregon State Agricultural College.)

Fireless brooders have not given very good satisfaction. One poultry breeder in California used the fireless brooders with excellent success for two years, though the chicks were hatched later in the season than usual. It was tried again this year, early in the season, and was a total failure. The great difficulty is to keep the brooder perfectly dry. It is doubtful if the "Fireless" system would prove satisfactory in this Province, with its moist climate; certainly not with the early hatches.

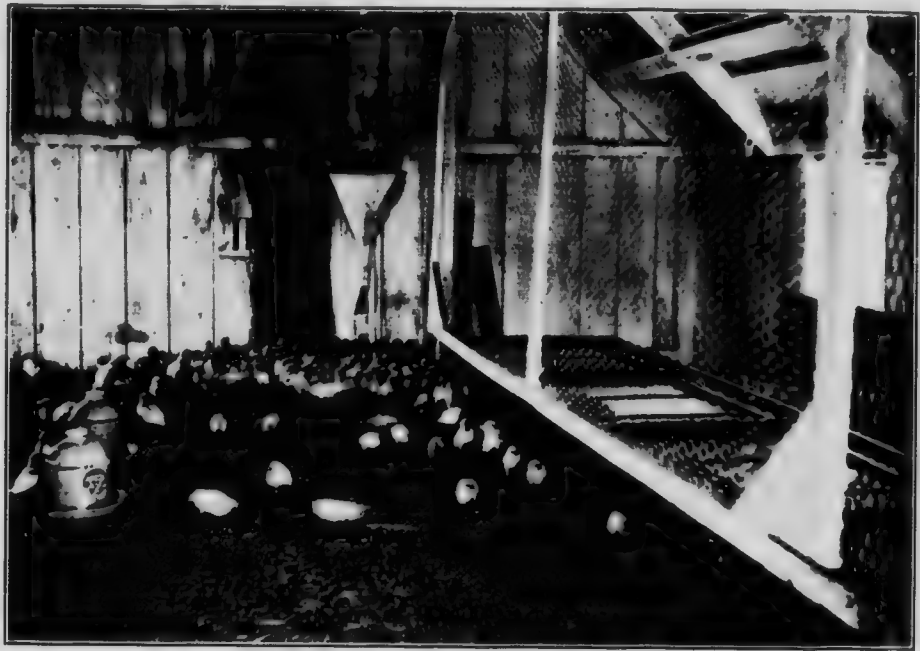


FIG. 18.—The fireless brooder. Note the condition of the chicks.

Artificial heat has been supplied to these brooders with very good results. This tends to keep the brooder from "sweating," and the chicks seem to do well. Heat may be supplied for the first week by means of hot-water pipes, heated bricks, or compressed stone. This system necessarily involves more labor than with the hover system.

Another system of brooding chicks involves the use of gasoline. The chief feature of this system is that the cost of brooding is materially lessened. Also there is less labor, since one hundred

and fifty or two hundred chicks may be brooded together. The gasoline is placed in a tank considerably above the burner, and is connected with the burner by the use of half-inch pipes. The burner is placed under the brooder house, directly under the middle of the circular drum. The drum is fastened to the hover, which may be round or otherwise, and which is hinged to the side of the house. Gas which is generated from the gasoline is ignited at the burner, and this heats the drum, a flue passing through the floor into the centre of the drum. An outlet at the back of the drum connects with a flue running up the back of the house which allows fumes to pass off. The temperature may be controlled by the use of thermostats. This system involves the same principles as in the round hover brooding.

Instead of using gasoline with the galvanized iron drum, the same kind of a brooder may be heated by means of hot water pipes. Inch pipes run lengthwise of the hover, being slightly lower at one end than the other. At the low end, heat is supplied by burning kerosene. The heated water flows to the upper end, and



FIG. 19. The "room" brooder. One thousand or more chicks may be brooded together. The supply tank is shown in upper right hand corner.

as it gradually becomes cooled it flows back to the lower end. In this way a continual circulation has been kept up, and a fairly even temperature may be maintained.

Many poultrymen of California have discarded this method, and have adopted the comparatively new method of "room" brooding. An idea of this system may be gained from Figure 16. This brooder house is twenty feet long by twelve wide, is divided into two equal parts. In each room is a distillate burner, which heats the room for one thousand four hundred chickens. In the upper right hand corner of Fig. 19 may be seen a galvanized iron tank. This is the supply tank for the burner. Three grades of oil—engine, No. 28 and No. 34—may be used, but the engine oil is more satisfactory than either of the other grades. All of these grades are extracts of the crude oil. From the supply tank the oil passes through pipes under the floor, to the burner. The burner is in the centre of the stove, and from the base of the stove a pipe reaches up to and through the ceiling. About three feet from the floor, as shown in Figure 19, a large umbrella-shaped hover is attached to the pipe. This tends to keep the heat generated from the burning gas near the floor. Considerable care must be exercised in lighting the burner. The valve at the supply tank and the valve at the burner are opened, and a small quantity of oil is allowed to run out. Then the burner valve is closed and the oil is ignited. This burning oil heats the burner, the heat of which in turn causes the oil, as it comes to the hot burner, to be converted into gas. When the burner has become sufficiently hot to convert the oil into gas, the burner valve is turned on and the gas is ignited. Up to the present, a reliable regulator has not been invented. The burner is, however, easily controlled. This method of brooding chicks is somewhat more expensive than other methods, though much less labor is involved. The adoption of this method would only be justified on large poultry plants.

The Continuous System

When chicks are raised in small numbers, the Colony system is necessary. This system is quite often practised on extensive poultry farms, while, on the other hand, the round hovers and other brooders originally adapted for the colony system are often installed in a continuous house. The larger the number of chicks that can be brooded together without doing any injury to one another, the less will be the cost. It is very doubtful if one thousand to one thousand five hundred chicks can be brooded together with entire satisfaction. Methods of brooding in California are in a somewhat experimental stage, and probably poultrymen in that country will find it more economical to brood their chicks in smaller numbers. On large plants, where chicks are to be raised on a large scale, the brooder



FIG. 20.- California brooder houses where the distillate burners are used. Eight of these houses may be seen in this photo, and in each house one thousand chicks are raised at one time.

house, heated by hot water pipes, is the most economical. In this case, only one building is required, and all the work to be done in caring for the chicks can be done in the one place. There is only one fire to tend, and the work of feeding and watering the chicks can be done much easier than when the chicks are scattered about in individual brooders. There is no doubt but that the chicks have a little better chance in the colony brooders, for they are kept in smaller numbers, have less restricted range, and have a better chance to pick up more of their living. But the extensive breeder must consider the cost and in this connection he will find it more economical to brood them in a continuous brooder. The furnace for heating purposes is usually situated in the basement, at one end of the brooder house. The pipes run from the furnace to the other end of the house and return. The pipes may be of any size, the inch and two-inch sizes being most frequently used. These pipes, two "out-flows" and two "in-flows" or more, if necessary, run parallel to one another the length of the house, and are about six inches

above the floor. The pipes are higher at the extreme end of the building than where they enter the furnace. This causes a continual flow of water, and an even temperature is quite readily maintained. Naturally the temperature at the end where the pipes are high would be somewhat lower than the temperature where the pipes are low and near the source of heat. The greatest difficulty in continuous house brooding is to keep proper temperatures for chicks of different ages. This difficulty is sometimes overcome by constructing partitions, making separate brooder pens, and in this way more satisfactory results may be obtained.

THE FEEDING OF THE CHICKS

As has been previously noted, nature provides for the sustenance of the chick until it is able to obtain food by its own efforts. The contents of the yolk sac is nourishing, and the chick need be given nothing until about fifty hours after hatching. If fed too soon there is a tendency for the material present in the yolk sac to remain unabsorbed. If this occurs, putrefactive changes soon take place, and eventually the chick dies.

Care should be taken not to overfeed the chicks, especially during the first two or three days after commencing to feed. Many different methods are employed, but only a few will be discussed. The important question of exercise should never be overlooked. Give the little chicks plenty to do; make them work for their living. Through exercise they develop tissue and become sturdy. Keep the floor of the brooder house well littered with clean fine litter. It should be about two inches deep to start with, and gradually made deeper. The more exercise the chicks are induced to take, the better will they develop.

They should be supplied with clean water from the start. Fresh sweet skim milk is an excellent tissue builder. Never give young chicks sour milk as a drink. A convenient water fountain is shown in Fig. 21.

Fine particles of grit and finely ground oyster shell may also be given for them to pick at. Green food should be supplied at all times. In California, kale is largely used for supplying green food, and there is no reason why it should not be grown more extensively in British Columbia. Lettuce may also be grown, as well as cabbages. The green food should be suspended from the ceiling, as in this way it is kept clean. Fine particles of charcoal may also be given them occasionally.

There are many different mixtures of foods advocated for chick feeding, and while some have special merits, good success has been obtained by feeding the chicks on some commercial chick food and dry mash mixture, along with the previously mentioned neces-

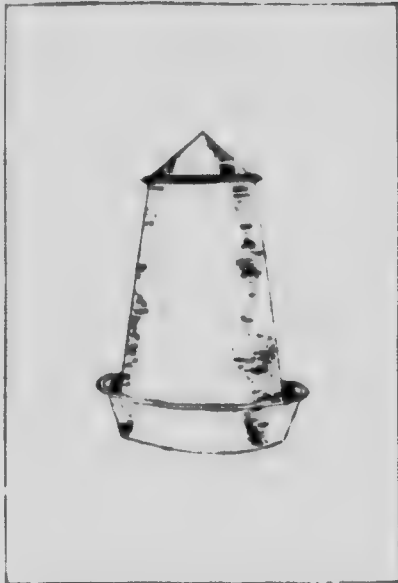


FIG. 21. A convenient water-fountain.

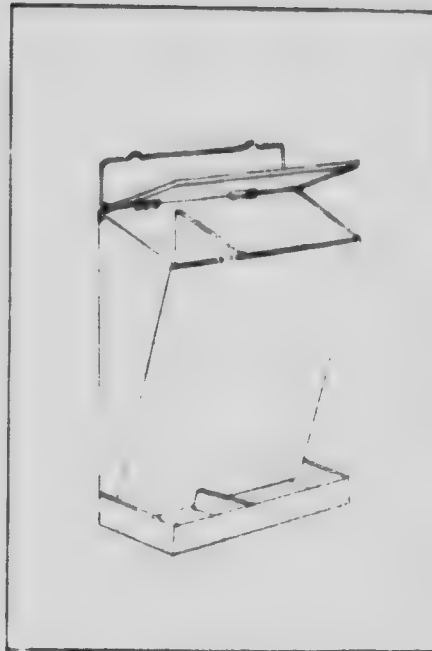


FIG. 22. A hopper for dry mash, bran, or beef scraps.

sities. It is best not to place dry mash before them for a few days, as this tends towards laziness and overeating. Teach them to scratch for the cracked grains in the litter. Below are given a few of the better methods of feeding chicks, with a few comments.

Methods of Feeding

No. 1.—Whole-wheat bread is fed for the first day or two, and is gradually substituted for johnny-cake. After a few days, cracked corn and cracked wheat are fed. The johnny-cake is made of five parts cornmeal, one part wheat middlings, and one part beef scrap, with a little soda mixed with sour milk and steamed until thoroughly cooked. Another johnny-cake is made of two and a half quarts of bran, two and a half quarts of cornmeal, two quarts of ground oats sifted, one quart of clover meal, half quart of beef scraps. These are mixed dry and half a dozen infertile eggs are added. Mix with milk or water and add one teaspoonful of soda. Mix the whole thoroughly into a stiff dough and bake three to six hours in a slow oven.



FIG. 23. Many such places, which are admirably adapted for chicken raising, may be found in British Columbia.

No. 2.—Feed cracker crumbs or dried bread crumbs, thoroughly mixed with finely chopped, hard-boiled eggs. There should be four or five times as much crumbs as there is egg. Pinhead oatmeal or rolled oats are also used. The chicks are fed this several times a day, and after a time cracked grains are fed.

No. 3.—This method has been advocated by the Maine Experiment Station. Bread is made of a mixture of three parts cornmeal, one part wheat bran, and one part wheat middlings or flour. This is mixed with milk or water and salt is added. It is well baked in a slow oven. The infertile eggs are boiled until hard, and are finely ground, shell and all. One part ground egg and four parts bread crumb are then mixed together and run through a sausage mill. The chicks are fed in the morning and at night on the bread and egg mixture. From after the morning feed until night they scratch in the litter for the dry cracked grain or chick food which is provided for them. The egg mixture is used for about two weeks, after which time grains and masnes are used.

No. 4.—From the first, the chicks are fed cracked wheat and finely cracked corn. This is scattered in the litter, and rolled oats are fed once or twice a day. In a few days a hopper of wheat bran is placed before them. In about two weeks this bran is replaced with a dry mash consisting of two parts cornmeal, three parts bran, two parts finely crushed oats, sifted, one part middlings, and one part beef scraps.

No. 5.—While the foregoing methods have commendable features, the following, though simple and involving less labour, gives good results and is much more satisfactory in feeding large flocks. During the first two or three days after feeding commences, the chicks are fed some good commercial "chick feed" or a mixture of finely cracked corn, cracked wheat and a very little millet seed may be used. In California they add to this cracked rice. The chicks are given this mixture several times a day. It is scattered in the litter and they scratch vigorously for it. After two or three days, they are given a dry mash. There is no one best mash, though some are superior to others. A very good mash is composed of two parts of bran, one part cornmeal, one part crushed oats, sifted, one part cocoanut meal and one part beef scraps. This mash should be fed in a hopper similar to that shown in Fig. 22. When feeding this mash, for the first time, it is best to give it immediately after they have had a good feed of their regular cracked grain ration. This will tend to keep the chicks from over-eating on the dry mash, and they will become accustomed to feeding from the hopper regularly. It is sometimes advisable to run the dry mash mixture through a sieve for the first few feedings. The chicks thrive well on this combination ration. Some poultrymen in California and other places add rolled oats to the cracked grain mix. 2. Rolled oats

forms one of the best chick feeds, and is comparatively inexpensive. Along with the cracked grains and dry mash green food in the form of kale or lettuce should be given. Grit, fine particles of oyster shell and clean water should be kept before the chicks at all times.

THE FEEDING AND HOUSING OF THE GROWING STOCK

When the chicks have become old enough and hardy enough to do without artificial heat, the brooder house may be transferred into a colony house, or they may be removed from the continuous brooder house and placed in colony houses. The best results may be obtained from growing stock on free range. They should be properly fed and housed, but the methods employed depend upon the purposes of the breeder. Different methods of feeding would be used in the production of broilers and breeders or layers. The chickens should be separated as soon as possible, the males and inferior stock, from the good females. This system should be especially adopted on large plants, where the cockerels and inferior stock should be placed upon the market at the earliest opportunity. The males which are kept for breeders and the females which are kept for layers and breeders should receive different treatment from the rest of the stock.

Feeding

Whatever stock is intended for the early market should be forced as rapidly as possible. In this case, especially with broilers, wet mash along with the whole grains should be used. The whole grains should be corn, wheat and oats. The mash may be the same as that used for the dry mash for chicks or a mash composed of two parts cornmeal, two parts middlings, two parts beef scraps, one part wheat bran and one part alfalfa may be mixed with skim milk or water, and fed once or twice a day. If green bone is available, the quantity of beef scraps in the wet mash should be reduced. This mash should be fed in V-shaped troughs which should be kept perfectly clean and sweet. Skim milk given as drink is excellent. It is a good tissue builder, and seems to impart a superior flavor to the flesh. Broilers should weigh from one and a half to two and a half pounds when ready for the market. They should weigh this in about ten or twelve weeks, depending to a certain extent upon the breed.

All stock which is intended for later fattening should not be forced as heavily during the growing period. The aim should be to have a large frame develop, to which a large quantity of flesh may be added. This class of stock should be given plenty of free range, with a variety of food.



FIG. 24.—A California colony house. The chickens are placed in this house when about three months old.

The males and females for breeding purposes should be treated quite differently from stock intended for broilers and roasters. They should not be forced to any extent during the growing period. If the pullets are forced they may lay prematurely. They should develop large frames and have strong constitutions. The amount of concentrated food in the ration should be lower than in a fattening ration. Free range is necessary. A whole grain mixture in the proportion of one pound corn, one pound wheat and one pound oats, answers well. This may be changed to three pounds corn, three pounds wheat, two pounds oats and one pound buckwheat. The pullets should be fed rather lightly on mash, which may be compounded as any of the previously mentioned ones. Beef scraps may be fed in a separate hopper, but care should be taken to avoid any waste. Many poultrymen feed the whole grain by the hopper system. This is practised quite extensively in certain parts of California, where they have several thousand fowls on each plant. This method saves a great deal of labor, but it is doubtful if as satisfactory results may be obtained as in hand feeding. On small



FIG. 26. The Wood's open front house.

plants better results may be expected where the whole grain is fed regularly from the hand. The important point is to so feed and care for them that they will be fully matured before commencing to lay.

Housing

The Wood's open-air poultry house is simple, convenient, and comparatively inexpensive. It is cool in summer and comfortable in winter. It provides for an abundant supply of fresh air at all times, and the sun's rays may also reach every portion of the roosting quarters, while at the same time dampness is largely prevented from entering. If properly constructed it is draught-proof.

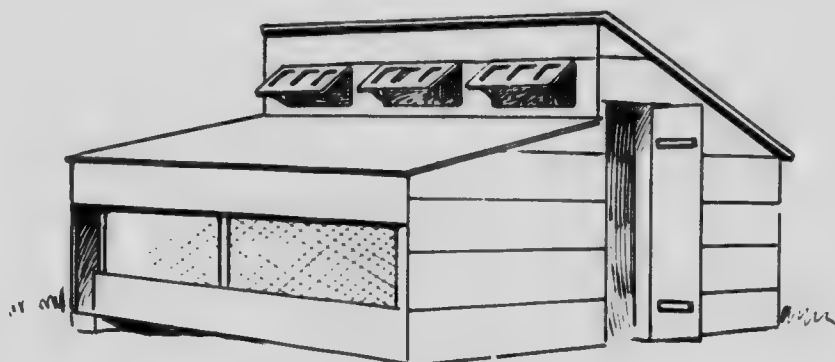


FIG. 26.—Line sketch of Wood's house.

This house may be constructed in different ways, although its essential feature should not be lost sight of. Figures 26 and 28 show slightly different constructions. In Figure 26 the front portion of the house is about eight feet deep, while in Figure 28 the front portion is six feet deep. The house may also be built with the front being seven feet deep and the rear section also seven feet. These differences are more or less immaterial, and a house with the front section eight feet deep and the back six feet deep may be more satisfactory in some places than one where the front is six feet deep and the back eight. Also this house is often built eight feet wide and twelve deep. When it is to be used as a colony house its dimensions may be reduced to suit the convenience of the builder. There is a great need for a colony house which may be moved about in stump land. The Wood's house is admirably adapted for growing stock. Other houses are probably as satisfactory, and the A-shaped colony house, especially, is more convenient than the larger houses.

The Wood's house may also be used as a laying house, and the plan for such is here given. There are a few places where earth floors may be as satisfactory as board floors, but as a rule board floors are preferable. The house may be kept cleaner, dryer, and vermin are more easily kept out. Fig. 27 shows the ground plan of a house ten feet wide by fourteen feet deep. This plan shows position of sills, studs, window and door, and the location of roosts, drop boards and nests. Figure 28 shows side elevation of house. In the figure the position of the posts, plates, studs, and

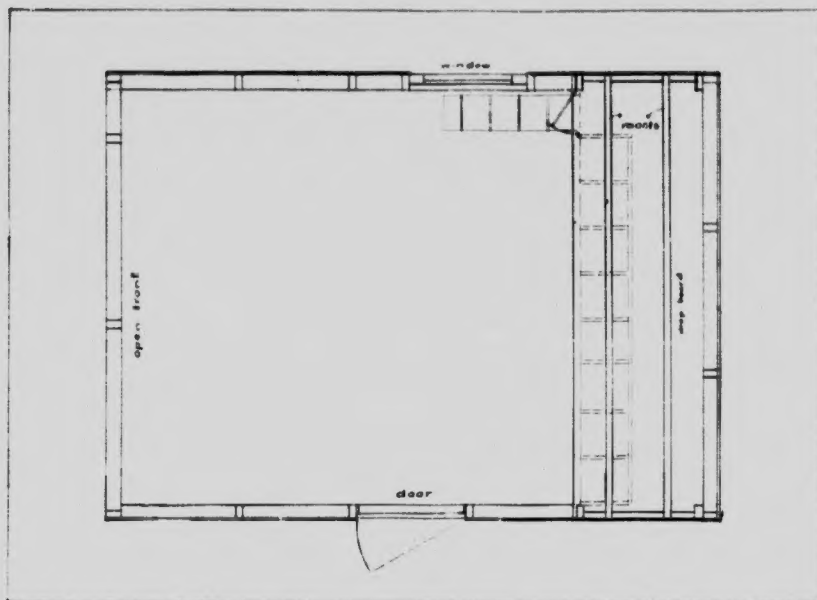


FIG. 27.—Ground plan of Wood's house.

rafters is clearly shown. The position of the roosts, drop board and nests is also indicated, although the figure gives an incorrect idea of the construction of the nests. The construction of the nests is shown in Figure 29. They are made by making a row of boxes with no bottoms, to the front of which a hinged door is attached. This row of boxes is placed on board as shown in Figure 29, and is held in place by means of small blocks. To clean the nests, the row of boxes is raised above the holding block and is drawn out. Then the board upon which the nest box rests may be easily swept off

and kept clean. The interior arrangements are fixed so that the house is very convenient and easy to care for. Feed hoppers may be attached to the sides of the house above the floor.

The actual opening in front may vary with different houses. Usually it is two and one-half feet from top to bottom, though the width of the protection boards determine this. The protection board used at the top of the front would necessarily be wider in the wet belts of the Province than in the dry belts. It is advisable to have the lower board twelve inches wide. This tends to keep all

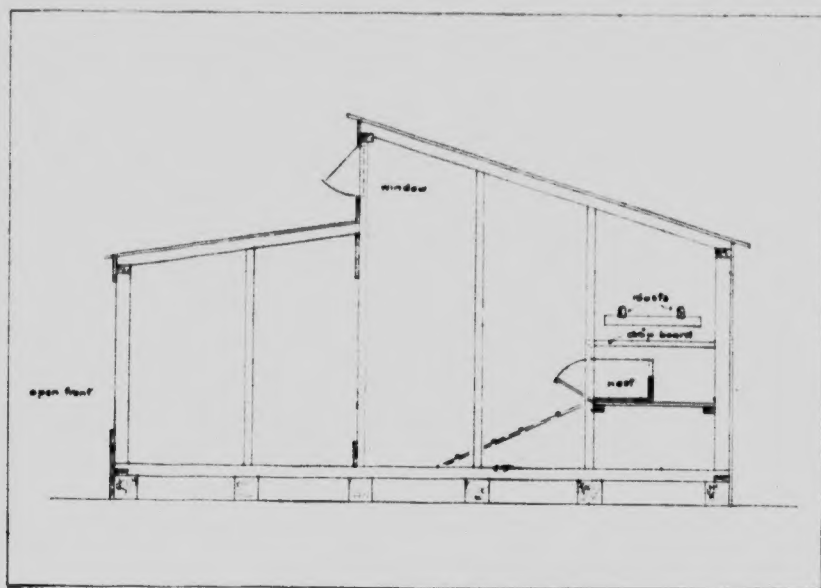


FIG. 28.—Side elevation of house.

litter from being scratched out of the house. Protection boards are also shown between the two sections of the house. If a board floor is used a protection board on the floor would be useless, as the whole floor space is used for scratching purposes. The upper protection board acts as a check board against any draughts. The position of the windows is shown in Figs. 25 and 26, as well as in Fig. 28. These should be on hinges, so that they may be opened when desirable. A door should be placed on one side, as indicated in Fig. 27, also a window may be placed in other side of the house.

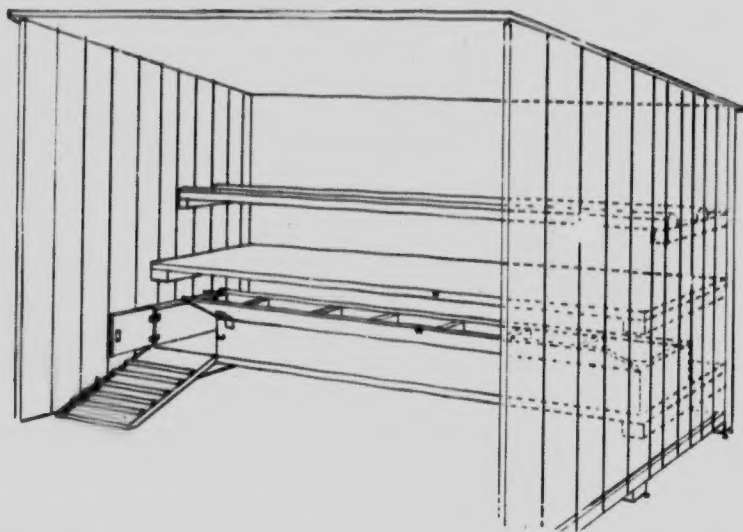


FIG. 29.—Line sketch of back part of house to show construction of nests.

The house should be located on well-drained soil and should face south or south-east. The foundation should be made solid, and the sills and studs, plates and rafters fixed firm. The three sides should be made absolutely tight. Roofing materials or shingles may be used for the roof. When properly constructed, it is a serviceable and durable house.

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